

GERMINATION OF INTACT AND NAKED SEED OF INDIAN RICEGRASS¹
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ABSTRACT

Indian ricegrass (*Oryzopsis hymenoides* (Roem. & Schult.) Ricker) exhibits two types of seed dormancy: mechanical, which persists as long as the seed coat is not ruptured, and physiological, believed to be a result of low levels of endogenous giberellins in freshly harvested seed. Six accessions were tested for germination with lemma and palea present (intact seed) and absent (naked seed). Seeds were planted on blotter paper and prechilled for 4 wk at 5°C before the 3-wk 15°C(9 h)/5°C(15 h) test. Seeds were less than six mo old when evaluated and exhibited more physiological dormancy than mechanical dormancy. Differences among the accessions were observed for germination of intact and naked seed. Germination of intact and naked seed from the same accession was positively correlated. Mechanical dormancy and physiological dormancy were negatively correlated across accessions.

Additional index words: *Oryzopsis hymenoides* (Roem. & Schult.) Ricker, Seed dormancy.

INTRODUCTION

Indian ricegrass (*Oryzopsis hymenoides* (Roem. & Schult.) Ricker) is a dominant perennial grass species of the low elevation salt desert ranges of the sagebrush vegetation zone (Young and Evans, 1984). This grass is highly palatable and cures well for winter utilization (Robertson, 1976; Booth et al. 1980). It could be an excellent species for revegetation of mine spoils (Zemetra et al., 1983) and sand dunes (Young et al., 1983), but high seed dormancy hinders stand establishment.

Huntamer (1934) described two seed dormancy mechanisms operating in Indian ricegrass, mechanical and physiological. Mechanical dormancy is a result of the indurate lemma and palea, which preclude penetration of O₂ and H₂O required for germination (McDonald and Khan, 1977). Mechanical dormancy may be eliminated by removing the lemma and palea from the seed, as the seed coat is then easily ruptured (M. B. McDonald, 1987, personal communication). Physiological dormancy may result from an inherent deficiency of endogenous giberellins (McDonald, 1987) and is known to decrease over time (Rogler, 1960; Zemetra and Cuany, 1984). The effect of production year or the years over which seed was stored (Rogler, 1960) influenced the level of physiological dormancy and its loss over time. Storage at 25°C/65% relative humidity increased germination over storage at 4°C/15% relative humidity (McDonald and Khan, 1977).

The correlation between seed dormancy and polymorphism has been a research topic since Huntamer (1934) noted that two classes of seed,

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small black and large black, were present in some lots. Large black seeds matured earlier and shattered more readily than small black seeds. Young and Evans (1984) found that small black seeds exhibited lower dormancy than large black seeds. Huntamer (1934), Stoddart and Wilkinson (1938), and Toole (1940) reported that, within an accession, small seeds required less acid scarification for germination than did large seeds. Plummer and Frischknecht (1952), however, found that the correlation was not consistent over the 106 accessions they tested. They did conclude that differences in seed size were heritable. Lemma thickness was correlated with viability after acid scarification and was determined to be primarily under genetic control (Zemtra and Cuany, 1984). Stoddart and Wilkinson (1983) noted "immediate" germination and Young and Evans (1984) reported 100% germination of naked seed, from which the indurate lemma and palea had been removed.

Past efforts to improve germination of Indian ricegrass have emphasized cool-temperature stratification, mechanical and sulfuric acid scarification, and gibberellic acid application. While all these treatments can improve germination, seed dormancy remains a limiting factor in laboratory germination as well as field emergence. Previous attempts to evaluate germination of Indian ricegrass have usually used only a single germplasm source and have usually not stated the age or storage conditions of the seed. Our objective was to evaluate the dormancy of recently harvested seed from six native-site accessions with lemma and palea intact and removed. We also correlated intact with naked seed germination and mechanical with physiological dormancy across six accessions.

MATERIALS AND METHODS

Seed of six Indian ricegrass accessions, collected at five sites in Nevada and one in Oregon, were separated according to seed polymorphic classes (Young and Evans, 1984) (Table 1).

Table 1. Percentage of seed of six accessions in naked and intact highest hundred-seed weight (HHSW) classes.

ID	Date Collected	Location	Naked HHSW	Intact HHSW	Other
			-----%		
Acc:83	6-23-86	Washoe Co., NV	8.8	24.8	66.4
Acc:85	6-24-86	Granite Ridge, NV	10.5	36.3	53.2
Acc:86	6-26-86	Mill City, NV	6.8	33.9	59.3
Acc:89	6-27-86	Deeth, NV	15.6	40.5	43.9
T-31	7-21-86	3 km SW Deeth, NV	10.9	22.9	66.1
T-57	7-17-86	Pleasant Valley, OR	48.1	40.6	11.2

The classes were distinct and exhibited polymorphic variation in presence of lemma and palea, size, shape, color, seed weight, and endosperm development. The naked seed in these lots lost their lemmas and paleas as the panicles were rubbed vigorously with a rubber-covered block during threshing. There were three to six polymorphisms within each seed lot.

The six accessions used here were chosen because they had sufficiently high quantities of naked seed for germination tests. Within each accession, only the naked seed polymorphism with the highest hundred-seed weight (HHSW) and the polymorphism having intact lemma and palea with the HHSW were tested. We used the HHSW polymorphism of both naked and intact groups (Table 2) because they should have been the most viable.

Table 2. Hundred-seed weights of six accessions and their naked and intact highest hundred-seed weight (HHSW) classes.

Accession	Unseparated	Naked HHSW	Intact HHSW
	----- mg -----		
Acc:83	242	292	371
Acc:85	226	261	318
Acc:86	228	232	297
Acc:89	176	188	230
T-31	408	266	783
T-57	166	192	161

Seeds were dusted with tetramethylthiuram disulfide (Thiram) fungicide and planted on blotters lying on sponges saturated with distilled water in plastic germination boxes. One hundred seeds, stored at room temperature since threshing, were planted in each box December 18, 1986. This was five to six mo post-harvest (Table 1). Each of 10 rows of 10 seeds apiece in each box comprised a randomized unit. Four hundred seeds of each of the 12 groups of seeds (six accessions x two polymorphisms) were planted in 40 replicates of one row apiece in a completely randomized design. A prechill treatment of 5°C for 4 wk was followed by alternating temperatures of 15°C for 9 h and 5°C for 15 h for an additional 3 wk (Clark and Bass, 1970). This is similar to the Association of Official Seed Analysts (AOSA) alternate method (Assoc. Off. Seed Anal., 1981), except the test lasted 3 wk instead of 4 wk.

An angular transformation was applied to the data before analysis. Comparison of the germination percentage of naked and intact seed was made in each accession. Analysis of variance was employed to detect differences in germination rates among the accessions in both naked and intact groups. Separation of means was performed with the Waller-Duncan k-ratio t test, also known as the Bayes LSD, at k-ratio = 100 (Smith, 1978).

A germination regime which includes prechill reduces physiological dormancy, but should have little effect on mechanical dormancy. Thus, the magnitude of mechanical dormancy in an accession was expressed as the difference in germination between naked seed germination percentage and intact seed germination percentage, each based on 400 seeds. Physiological dormancy remaining after prechill was calculated as 100 minus naked seed germination percentage, based on 400 seeds. This calculation assumes high viability, which we consider reasonable since the seed was recently harvested, thoroughly cleaned, and high in hundred-seed weight.

Since naked seed germination was used to calculate both mechanical dormancy (naked seed germination percentage — intact seed germination percentage), an intrinsic negative correlation between the two was present when the same sample of naked seed was used to calculate both. Therefore, to correlate mechanical and physiological dormancy across accessions, we made two independent estimates of naked seed germination for each accession. Twenty rows were randomly assigned for use in one estimate and the remaining 20 rows were assigned to the other estimate. The two 200-seed estimates were used separately, one to calculate mechanical dormancy and the other to calculate physiological dormancy. A 200-seed estimate of intact seed germination was also used for calculation of mechanical dormancy. These 200-seed estimates were used to correlate mechanical and physiological dormancy across accessions, but the 400-seed estimates were used to report values for mechanical and physiological dormancy of each accession.

RESULTS AND DISCUSSION

Averaged over all six accessions, germination percentage of naked seed (19.1%) was significantly higher ($p < 0.01$) than that of intact seed (2.8%). This difference was present in each of the six accessions (Table 3). Naked seed germination was much lower than the 100% reported by Young and Evans (1984), who germinated at 20°C for 2 wk without a prechill pretreatment. The germination of naked seed we saw was similar to results of Clark and Bass (1970). The extent of naked seed germination relates to degree of physiological dormancy, which declines over time. Thus, this result is greatly influenced by seed age at time of testing.

Table 3. Germination percentages of naked and intact highest hundred-seed weight (HHSW) classes, calculated mechanical dormancy, and calculated physiological dormancy remaining after prechilling in six accessions, all based on 400-seed samples.

Accession	Naked HHSW germination	Intact HHSW germination	Mechanical dormancy	Physiological dormancy
	-----%			
Acc:89	27a†	8a†	19	73
T-57	22ab	6b	16	78
T-31	22ab	1c	21	78
Acc:83	20b	1c	20	80
Acc:85	13c	1c	12	88
Acc:86	12c	0c	12	88

† Accessions followed by different letters are significantly different at $k\text{-ratio} = 100$ according to the Waller-Duncan $k\text{-ratio}$ t test.

Considerable differences ($p < 0.01$) were observed among accessions for germination of naked and intact seed (Table 3). These differences could be genetic, environmental, or both. Seed maturity is likely impor-

tant since seed from a native site is collected at a single time and Indian ricegrass exhibits an indeterminate flowering pattern. It is not unusual to see a single plant with some panicles shattering as other panicles emerge from the boot. Seed of some polymorphic classes matures earlier and shatters more than others (Huntamer, 1934). Since seed of these classes may exhibit different levels of dormancy (Young and Evans, 1984), stage of maturity at harvest may affect dormancy of a seed lot.

Naked seed have only physiological dormancy, whereas intact seed have mechanical dormancy as well. The correlation between germination of intact and naked seed across accessions was 0.78 ($p < 0.10$). This positive correlation may be a result of physiological dormancy, which should be similar within an accession regardless of whether the seed is intact or naked. The correlation between the calculated measure of mechanical dormancy and the physiological dormancy remaining after prechill was -0.74 ($p < 0.10$). This negative value suggests that an accession such as Acc:89 may partially compensate for its relatively low physiological dormancy with a relatively high mechanical dormancy. An accession such as Acc: 86 may partially compensate for its relatively low mechanical dormancy with a relatively high physiological dormancy. To develop low-dormancy germplasm, we must identify more materials with both low mechanical dormancy and low physiological dormancy. This effort may be complicated by a negative correlation between the two types of dormancy.

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